

# PATENT ABSTRACTS OF JAPAN

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(71)Applicant : NIPPON STEEL CORP

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(72)Inventor : TSUCHINAGA MASAMITSU

YAMAJI KIYOSHI

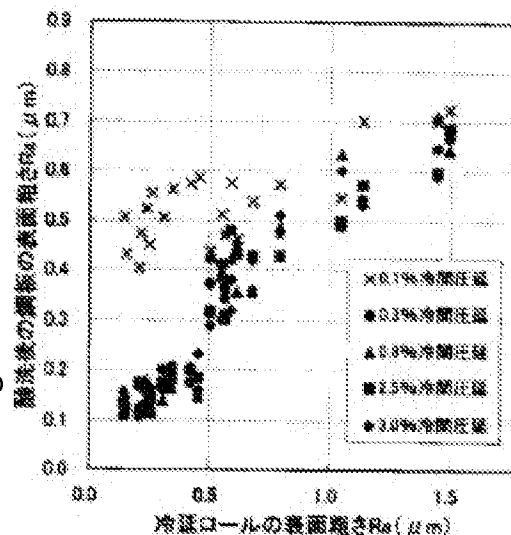
TAKAHASHI AKIHIKO

## (54) METHOD OF PRODUCING STAINLESS STEEL SHEET HAVING SMOOTH SURFACE

(57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a method of producing a stainless steel sheet having a smooth surface by which the surface roughness of a steel strip which is obtained by cold rolling of stainless steel and which is annealed in a weakly oxidizing atmosphere and electrolytically picked can be reduced and stabilized.

**SOLUTION:** The steel strip obtained by cold rolling of stainless steel is annealed in the range of the recrystallization starting temperature of the steel sheet to the recrystallization finishing temperature +20 to +60°C in a weak oxidizing atmosphere in the range of a dew point -15 to -40°C. Next, cold rolling of 0.3 to 2.5% is performed by using cold rolling rolls with a surface roughness Ra of  $\leq 0.5 \mu\text{m}$ , or thickness reduction strain of 0.3 to 2.5% is applied thereto with bending rolls with a surface roughness Ra of  $\leq 0.5 \mu\text{m}$ . The steel sheet is thereafter subjected to electrolytic pickling with a pickling solution obtained by adding a fluorosilicate or fluoroborate to a 20 to 400 g/L sulfuric aqueous solution, and further mixing one or two kinds selected from a nitrate and sulfate therein.



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2.\*\*\*\* shows the word which can not be translated.

3.In the drawings, any words are not translated.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention is the art about the method of manufacturing the steel strip which has the smooth surface, when annealing the steel strip after cold rolling of stainless steel and manufacturing it as a steel strip with sufficient processability.

[0002]

[Description of the Prior Art]About manufacture of the cold-rolled steel strip of stainless steel, after descaling the scale of the hot coil after hot-rolling, pickling is cold-rolled, annealed and carried out and it is manufactured as a product. Such a steel plate is used for the surface of various apparatus in many cases, and it is called for that it is beautiful in a finish schedule side.

[0003]About pickling carried out in front of the product of these cold-rolled strip processing methods, in JP,S61-276999,A. The method of obtaining the beautiful steel plate of a finish schedule side is shown by by carrying out electrolytic pickling of the Cr containing steel sheet to the sulfuric acid solution of specific concentration with the solution which added fluosilicate or a fluoroborate and a nitrate, or sulfate.

[0004]About annealing and pickling which are carried out in front of the product of these cold-rolled strip processing methods, in JP,S3-90600,A. It is -15 - -a little less than 40 \*\* oxidizing atmosphere about the dew point about Cr content cold rolled sheet steel, and anneals in the with the recrystallization starting temperature of a steel plate - a completion temperature of recrystallization of +50 \*\* range, and the method of carrying out high-speed mass production of the smooth steel plate of appearance is shown by carrying out electrolytic pickling in the sulfuric acid solution which added fluosilicate etc.

[0005]

[Problem(s) to be Solved by the Invention]As a result of performing still more detailed

examination about these manufacturing methods, the following things became clear. When a cold-rolled steel strip was manufactured by the method shown in JP,S61-276999,A and JP,S3-90600,A, it turned out that big variation arises in the granularity of the cold-rolled steel strip surfaces after annealing pickling. The purpose of this invention is to stabilize small the product surface granularity which was not able to be attained in conventional technology.

[0006]

[Means for Solving the Problem]In order to solve this SUBJECT, a steel strip after cold rolling of stainless steel in dew point-15--40 \*\* weak acid voltinism atmosphere, In the with recrystallization starting temperature of a steel plate - a completion temperature of recrystallization of +60 \*\* range, anneal and next, . [ whether surface roughness carries out 0.3 to 2.5% of cold rolling using a cold rolling roll not more than Ra0.5micrometer, and ] Or after surface roughness gives 0.3 to 2.5% of thinning distortion with a bending roll not more than Ra0.5micrometer, In 20-400-g/L sulfuric acid solution, fluosilicate, such as  $\text{Na}_2\text{SiF}_6$ , Or it is effective to perform to carry out electrolytic pickling with a pickling solution which added fluoroborates, such as  $\text{NaBF}_4$ , and also mixed one sort of nitrates, such as  $\text{NaNO}_3$  and  $\text{Na}_2\text{SO}_4$ , and sulfate or two sorts.

[0007]

[Embodiment of the Invention]As a result of performing various detailed examination for business solution, considered it as the method of stabilizing product surface granularity small, and after annealing the steel strip after cold rolling, mechanical DESUKE was made to act, and it found out that \*\*\*\*\* which carries out electrolytic pickling with a predetermined pickling solution was the most effective. Hereafter, it explains according to an experimental result.

[0008]When a cold-rolled steel strip was manufactured by the method shown in JP,61-276999,A and JP,S3-90600,A, it turned out that big variation arises in the granularity of the cold-rolled steel strip surfaces after annealing pickling. As a result of examining this cause, it became clear that it was for the state of the scale generated with the dew point at the time of annealing or change of cooking temperature to change, and for change to arise in the grade of pickling within a plate surface.

[0009]In order to stabilize the granularity after this pickling small, the method by mechanical DESUKE was examined. The steel strip of 0.2 micrometer of surface roughness after cold rolling of SUS430 is annealed for 20 sec at the temperature of 850 \*\* which took into consideration a recrystallization start and the completion of recrystallization of the steel plate in dew point-20 \*\* weak acid voltinism atmosphere. Next, surface roughness performs 0.1 to 3.0% of cold rolling using the cold rolling roll which is 0.1-1.5 micrometers of Ra, Into 100-g/L sulfuric acid solution, 20 g/L of steel strips were used as the negative pole with the current density of  $40 \text{ A/Dm}^2$  with  $\text{Na}_2\text{SiF}_6$  and the pickling solution which mixed  $\text{NaNO}_3$  and 50

g/LNa<sub>2</sub>SO<sub>4</sub> of 50 g/L, and electrolytic pickling was carried out for 10 sec at 80 °C.

[0010]Thus, the surface roughness of a roll, the rolling reduction, and the relation of the surface roughness after pickling which were manufactured are shown in drawing 1. It is the same as the case where it does not press down in the rolling reduction of 0.1%, and any surface roughness of a roll is large and the variation of the surface roughness of the steel plate after pickling is also large. By 0.3% or more of pressing down, if surface roughness of a roll is made small, the surface roughness of the steel plate after pickling will also become small. In this case, becoming coarse turned out for roll granularity to exceed 0.5 micrometer.

[0011]Thus, why \*\*\*\*\* which crab cull DESUKE is made to act and carries out electrolytic pickling with a predetermined pickling solution is effective, The scale which it was heated in weak acid voltinism atmosphere, and was generated is precise, and it is because the lytic reaction between the metal part under the scale and a pickling solution is checked, and mechanical descaling is considered to act effectively in order to make this lytic reaction act uniformly.

[0012]Next, the Reason for limitation is explained. About the steel strip after cold rolling of stainless steel, it is considered as the steel strip containing 8 to 25% of the amount of Cr(s). It is for generating the precise scale in this steel plate, if cold rolled sheet steel is heated even if it is among weak acid voltinism atmosphere.

[0013]About the annealing conditions of a cold-rolled steel strip, the dew point is carried out the inside of -15--40 °C weak acid voltinism atmosphere. -In 15--40 °C, the scale which is easy to carry out electrolytic pickling generates. It is for the scale of thickness unremovable from -15 °C by electrolytic pickling at an elevated temperature to generate on the other hand, and the dew point is for an installation cost to increase to obtain the low-temperature dew point from -40 °C, although it is so good that it is low.

[0014]This weak acid voltinism atmosphere is acquired by adding hydrogen 1 to 20% into nitrogen. If hydrogen concentration is less than 1%, the thickness of the scale will become remarkably thick, and the pickling work done later becomes complicated. The cost of the gas which will be supplied if hydrogen concentration exceeds 20% increases, and a problem is also caused to the safety control in respect of operation.

[0015]In order to consider it as the soft steel strip which is easy to process a product steel strip, it anneals in the with the recrystallization starting temperature of a steel plate - a completion temperature of recrystallization of +60 °C range. Elasticity-ization is not stabilized in less than recrystallization starting temperature. On the other hand, it is because [ exceeding the completion temperature of recrystallization of +60 °C ]-izing of the organization cannot be carried out [ fixed ] that it is easy to carry out grain growth.

[0016]The cold rolling roll for mechanical descaling makes surface roughness less than Ra0.5micrometer, and carries out 0.3 to 2.5% of cold rolling. When surface roughness carries

out 0.3 to 2.5% of cold rolling by less than Ra0.5micrometer, surface roughness of the steel plate after pickling can be made into high smoothness. If roll surface granularity Ra0.5micrometer is exceeded, the surface roughness of the steel plate after pickling will not be stabilized, but it will become large, and with the rolling reduction of less than 0.3%, it is ineffective and the grade of work hardening becomes large on the conditions exceeding 2.5%. [0017]The method by a bending roll is also useful because of mechanical descaling. Also in this case, surface roughness of a roll can be made less than Ra0.5micrometer, and surface roughness of the steel plate after pickling can be made into high smoothness by giving 0.3 to 2.5% of thinning distortion. If roll surface granularity Ra0.5micrometer is exceeded, the surface roughness of the steel plate after pickling will not be stabilized, but it will become large. thinning distortion which thinning distortion is ineffective at less than 0.3%, and exceeded 2.5% -- if -- the grade of work hardening becomes large.

[0018]As an electrolytic-pickling solution, in 20-400-g/L (liter) sulfuric acid solution, Fluoroborates, such as fluosilicate, such as  $\text{Na}_2\text{SiF}_6$ , or  $\text{NaBF}_4$ , are added, and also the pickling solution which mixed one sort of nitrates, such as  $\text{NaNO}_3$  and  $\text{Na}_2\text{SO}_4$ , and sulfate or two sorts is used. Electrolytic pickling stable with 20-400-g/L sulfuric acid is possible, and in less than 20 g/L, if pickling capability becomes extremely small and exceeds 400 g/L, it will become difficult to control pickling capability.

[0019]Fluoroborates, such as fluosilicate, such as  $\text{Na}_2\text{SiF}_6$ , or  $\text{NaBF}_4$ , are added in order to raise the removing speed of the scale substantially. As the addition, per [ sulfuric acid solution 1L / 1-50g ] are preferred. An effect is saturated with less than 1g per sulfuric acid solution 1L, even if an effect is hardly seen but exceeds 50 g on the other hand.

[0020]When a steel strip negative-pole-izes at the time of electrolytic pickling, in order to promote the dissolution of a base, nitrates, such as  $\text{NaNO}_3$ , add sulfate of  $\text{Na}_2\text{SO}_4$  etc. in order to control fault pickling in electrolytic pickling. As for the addition, it is preferred that sulfuric acid solution 1L per 50-400g adds. An effect is saturated with less than 50g per sulfuric acid solution 1L, even if an effect is hardly seen but exceeds 4000 g on the other hand.

[0021]Electrolytic pickling counters both sides of the steel strip which carries out plate leaping of the inside of an acid wash bath, and forms and carries out indirect energization pickling of 1 set of two positive plates, and the cathode plate. In order to accompany the surface which manufactured in such a procedure by the base dissolution of about 0.1-1 micrometer, it has the surface peculiar to pickling.

[0022]

[Example]The steel strip of 0.2 micrometer of surface roughness after cold rolling of SUS430 was annealed on the conditions shown in Table 1. Next, after surface roughness carried out 0.3 to 2.5% of cold rolling using the cold rolling roll not more than Ra0.5micrometer or surface

roughness gave 0.3 to 2.5% of thinning distortion with the bending roll not more than Ra0.5micrometer, electrolytic pickling of the steel strip was carried out on the conditions shown in Table 2. Thus, as the manufactured steel strip after pickling showed the method according the method by a cold rolling roll to a bending roll to Table 3 in Table 4, each of surface smoothness and tensile strength became good. In the thing besides this condition, it was large, and variation also became big, and surface roughness became the steel plate with a large value of tensile strength work hardened.

[0023]

[Table 1]

焼鈍条件 No.	焼鈍条件			
	加熱雰囲気窒素 中の水素濃度 (%)	露点 (°C)	焼鈍温度 (°C)	保時間 (sec)
A1	13	-15	918	136
A2	17	-33	914	78
A3	20	-28	892	150
A4	1	-40	880	129
A5	16	-26	882	96
A6	4	-19	920	60

[0024]

[Table 2]

酸洗条件 No.	酸洗条件					温度 (°C)	電流密度 (A/Dm <sup>2</sup> )	電解時間 (sec)
	酸洗液組成(g/L)							
	H <sub>2</sub> SO <sub>4</sub> (g/L)	NaNO <sub>3</sub> (g/L)	Na <sub>2</sub> SO <sub>4</sub> (g/L)	Na <sub>2</sub> SiF <sub>6</sub> (g/L)	NaBF <sub>6</sub> (g/L)			
P1	113	164		7		79	24	4
P2	239	200		15		50	27	6
P3	400	173		5		90	46	9
P4	326		50	20		69	31	7
P5	221		200	19		60	60	3
P6	20		50	8		67	20	10
P7	113	164			9	79	24	4
P8	239	200			20	50	27	6
P9	400	173			14	90	46	9
P10	326		50		5	69	31	7
P11	221		200		12	60	60	3
P12	20		50		16	67	20	10

[0025]

[Table 3]

No.	焼鈍 条件 No.	メカニカルデスケーリングの条件			条件 No.	酸洗後の鋼板の表面		酸洗後の鋼板の材質		備 考
		メカニカルデ スケーリング法	冷間圧延 ロール の表面粗さ Ra(μm)	冷間圧延 率(冷間 圧延時) (%)		酸洗後の鋼 板の表面粗さ Ra(μm)	表 面 平滑性	引張強さ (N/mm <sup>2</sup> )	製品とし ての引張 強さ	
1	A4	冷間圧延	0.43	1.78	P4	0.21	○	483	○	本発明法
2	A2	"	0.33	2.25	P10	0.14	○	489	○	"
3	A2	"	0.27	0.94	P6	0.15	○	478	○	"
4	A2	"	0.38	2.11	P4	0.20	○	488	○	"
5	A6	"	0.27	1.62	P3	0.16	○	485	○	"
6	A5	"	0.32	0.51	P1	0.16	○	470	○	"
7	A3	"	0.11	0.61	P7	0.10	○	478	○	"
8	A2	"	0.13	2.15	P12	0.11	○	493	○	"
9	A4	"	0.38	1.87	P5	0.20	○	489	○	"
10	A4	"	0.13	1.75	P1	0.14	○	482	○	"
11	A3	"	0.37	1.89	P7	0.17	○	485	○	"
12	A3	"	0.14	1.33	P9	0.12	○	486	○	"
13	A1	"	0.42	2.09	P5	0.19	○	487	○	"
14	A2	"	0.35	1.05	P10	0.16	○	483	○	"
15	A3	"	0.96	0.71	P2	0.48	×	473	○	比較法
16	A6	"	1.12	3.16	P11	0.66	×	508	×	"
17	A6	"	1.37	2.87	P1	0.67	×	506	×	"
18	A3	"	1.11	1.84	P3	0.61	×	490	○	"
19	A6	"	0.55	3.08	P8	0.49	×	502	×	"
20	A3	"	0.14	0.20	P5	0.49	×	478	○	"
21	A2	"	0.65	1.19	P6	0.36	×	484	○	"
22	A5	"	0.43	3.76	P5	0.19	○	516	×	"
23	A5	"	0.64	2.18	P9	0.35	×	490	○	"
24	A4	"	0.77	2.63	P2	0.44	×	500	×	"
25	A4	"	0.69	3.89	P11	0.40	×	512	×	"
26	A4	"	0.27	3.98	P4	0.18	○	518	×	"
27	A3	"	0.69	0.68	P8	0.37	×	473	○	"
28	A6	"	1.12	1.60	P2	0.54	×	481	○	"
29	A2	"	0.55	2.19	P7	0.38	×	494	○	"
30	A1	"	1.11	0.18	P2	0.67	×	474	○	"
31	A1	"	0.89	0.05	P8	0.55	×	469	○	"
32	A5	"	1.26	0.16	P10	0.60	×	470	○	"
33	A5	"	0.65	2.73	P6	0.47	×	505	×	"
34	A3	"	0.66	1.08	P3	0.51	×	478	○	"
35	A1	"	0.79	0.12	P5	0.63	×	471	○	"
36	A4	"	1.37	1.08	P11	0.72	×	480	○	"
37	A2	"	0.33	3.73	P8	0.17	○	507	×	"
38	A1	"	0.77	0.67	P8	0.49	×	480	○	"
39	A2	メカニカル処理なし	-	-	P12	0.58	×	472	○	"
40	A2	"	-	-	P4	0.73	×	474	○	"
41	A2	"	-	-	P3	0.66	×	473	○	"
42	A6	"	-	-	P10	0.68	×	470	○	"
43	A1	"	-	-	P1	0.61	×	465	○	"

[0026]

[Table 4]

No.	焼鈍 条件 No.	メカニカルデスケーリングの条件			条件 No.	酸洗後の鋼板の表面		酸洗後の鋼板の材質		備 考
		メカニカルデ スケーリング法	ベンディング ロール の表面粗さ Ra(μm)	減肉率 (ベンディ ングロール 時)(%)		酸洗後の鋼 板の表面粗さ Ra(μm)	表 面 平滑性	引張強さ (N/mm <sup>2</sup> )	製品とし ての引張 強さ	
1	A5	ベンディングロール	0.35	0.54	P6	0.18	○	478	○	本発明法
2	A6	"	0.21	1.35	P2	0.15	○	487	○	"
3	A6	"	0.21	1.72	P5	0.13	○	489	○	"
4	A5	"	0.38	0.35	P7	0.16	○	473	○	"
5	A1	"	0.18	0.41	P2	0.13	○	474	○	"
6	A6	"	0.13	1.81	P12	0.10	○	484	○	"
7	A5	"	0.42	0.44	P6	0.21	○	475	○	"
8	A3	"	0.32	1.54	P4	0.16	○	482	○	"
9	A5	"	0.58	0.50	P1	0.46	×	470	○	比較法
10	A4	"	0.58	0.92	P12	0.30	×	475	○	"
11	A5	"	0.32	0.09	P1	0.53	×	487	○	"
12	A1	"	1.30	1.37	P6	0.71	×	484	○	"
13	A6	"	0.59	0.16	P1	0.50	×	468	○	"
14	A1	"	0.73	2.00	P10	0.47	×	488	○	"
15	A5	"	0.66	2.27	P4	0.36	×	490	○	"
16	A4	"	0.93	0.08	P11	0.52	×	474	○	"
17	A3	"	0.53	1.32	P1	0.41	×	477	○	"
18	A6	"	1.20	0.66	P3	0.64	×	479	○	"
19	A3	"	0.40	0.05	P3	0.59	×	471	○	"
20	A4	"	1.16	0.32	P7	0.64	×	475	○	"
21	A1	"	1.45	2.32	P11	0.62	×	491	○	"
22	A1	"	0.59	1.18	P3	0.32	×	479	○	"
23	A4	"	1.34	0.07	P3	0.61	×	472	○	"

[0027]

[Effect of the Invention]By this invention, by conventional technology, it could attain and the method of \*\*\*\* and product surface granularity were able to be stabilized small.

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[Translation done.]